The Evolution of the South African Science, Technology and Innovation System 1994-2009: An Exploration

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Abstract - **This paper is part of a longitudinal project on the evolution of the South African science, technology and innovation (STI) system since 1994, the year that marked the end of apartheid government. It was hypothesised that the overarching national (and international) commitment of the post-1994 government to reform society to become an inclusive system serving the needs of all changes would impact on four of the main pillars of the STI system, viz. national objectives, funding of the system, the human resource composition (specifically race) and steering/control mechanisms. The research approach consisted of qualitative analyses of published information reflecting the positions and initiatives of the government department entrusted with the oversight function of STI (Department of S&T). The analyses showed, firstly, that the core STI missions were changed substantially over time. Secondly, the funding of the system relative to GDP in effect stalled while new policies were put in place, but started rising moderately since 2001. Thirdly, extensive transformation has been brought about on the human resource dimension in terms of race equity, especially at management and executive level. Thirdly, the South African government has over the past decade introduced a range of new steering mechanisms and significantly tightened its control on public research institutions. The paper concludes by identifying four perspectives on the future of the STI system, viz. firstly STI for development of the disadvantaged components of society, secondly insistence on implementation time frames and M&E schedules for new initiatives, thirdly the government's commitment to grow the STI budget might be restrained, and fourthly increasing government control over publicly financed STI. In conclusion it was noted that the specific contents of these perspectives would be determined by the future direction of the country.**

I. Introduction

Officially the end of the apartheid political system in South Africa came in 1994 when the African National Congress of Nelson Mandela won a landslide victory in the first democratic election, afterwards to take over the reigns of political power. In principle that change of political power represented a change from an overtly pro-white system of discrimination – also at the level of the science, technology and innovation (STI) system - to a democratic black majority government. In the words of Mandela [1]: "Let each know that for each the body, the mind and the soul have been freed to fulfil themselves. Never, never and never again shall it be that this beautiful land will again experience the oppression of one by another..." (1994: 3). Political developments such as these afford an opportunity to study the influence of political transformation on selected dimensions of the STI system.

This paper is part of a longitudinal project started in 1999/2000 [2] and is scheduled to be completed in 2011. The paper is structured as follows: Main features of South Africa and its STI system, conceptual framework, hypothesis, research approach, policy objectives, enablement of the STI system, steering trough monitoring and control, conclusions, and future perspectives.

II. Main Features of South Africa and its STI System

It may be necessary to offer a thumbnail description of South Africa as context for the rest of the paper. The country is variously described as a developing and/or middle-income country.

A. Geo-political Characteristics

- Geographically, it lies at the southern tip of the African continent at the coordinates of 29 00 S, 24 00 E and covers approximately 1 219 090 square kilometres
- In 1994 it became a constitutional democracy with an executive president and a two house parliament; nine provinces; the most recent election took place in April 2009 which the African National Congress won by 66 percent of the vote;
- Demography: The most recent census showed a population of 48,5 million people [3]:
  - African: 38 565 100; Coloured: 4 379 200; Indian: 1 243 500; White: 4 499 200 [4]
  - Urban: 60%; Rural: 40% [5]
  - Adult literacy rate (2006): 74.4% [3]
  - Eleven official languages; 8,2% list English as first language
  - 5,7 m people living with AIDS; 350 000 deaths due to AIDS [estimates by 6]
- The economic dispensation can be described as a free market one with a strong and active labour union movement and much debate about stronger government interventions to alleviate the plight of the deprived parts of the population:

- GDP (2007): R1 994 billion US$283 billion [3]
- GDP per capita (2007): R41 120 / US$ 5 815 [3]
- Mean per capita income (2007): R1 514
- Inflation rate (March 2009): 5.4 % [7]
- Unemployment rate (first qrt 2009): 23.5 % [8]
- Gini coefficient (2007): 0.66 [9]
- Relevant competitiveness ranking [9]:
  - GCI ranking (2008): 44th out of 127 countries
  - IMD ranking (2008): 53rd out of 55 countries

In short, South Africa is a relatively complex country characterised by a large rural disadvantaged section of its population with all the characteristics of that.

B. The STI System

Against the above background the main features of the current South African science, technology and innovation (STI) system can be summarised as follows [cf. 10]:

- Three central ministries are involved in STI, viz. Departments of S&T, Trade and industry and Higher education
  - A regional innovation systems strategy is currently being developed
  - International cooperation: 47 bilateral agreements being serviced
  - GERD: 0.95%
- Public research institutions: Eight science councils
  - Researches: 2 255
  - Others: 3 543
  - Expenditure: R2 744 718 000 (16%)
- Government (museums, departments, etc.; excl. science councils)
  - Researchers: 1 111
  - Others: 1 813
  - Expenditure: R1 021 355 000 (6.2%)
- Higher education institutions: 23 universities
  - Researches: 27 746
  - Others: 4 287
  - Total number of students 761 087 [11]
  - Number of masters and doctoral enrolments (2006): 51 223 [11]
  - Number of masters and doctoral degrees awarded (2006): 9 158 [11]
  - SET enrolments (2006): 211 584 [9]
  - SET graduation (2006): 35 555 [9]
  - Expenditure: R3 298 808 000 (20%)
- Private / Business sector [12]:
  - Researchers: 8 227
  - Others: 9 240
  - Expenditure: R9 243 165 000 (55.9%)
- Productivity of the STI system [9]:
  - Publications (2006 in ISI journals): 4 971
  - Patents (2005): 125
  - Technology balance of payments (2006)
    - US$1 278 300 000 (payments)
    - US$ 456 000 000 (receipts)
    - Accredited South African scientific/scholarly journals: 255 [13]

In terms of its STI characteristics the country has a lot in common with middle income countries.

III. Conceptual Framework

For the purpose of this paper the STI system was conceived as a complex hierarchical system of role players (institutions and individuals) interacting within the context of policies and strategies by means of policy mechanisms and instruments towards the production of one or more or a combination of the following: new knowledge, technology, innovation and human resources. Public STI policy can be defined as the political course of action with regard to the generation, acquisition and application of knowledge to give effect to its vision for the country [cf. 2; 14]. Four pillars of policy are mission and objectives, funding, provision of human resources and control over the execution of the policy.

IV. Hypothesis

It was hypothesised that the change of political dispensation from a overtly pro-white discriminatory to a democratic black majority government would be reflected in changes to the objectives, steering and control of the national science, technology and innovation (STI) system. More specifically, it was hypothesised that the new government's policy would be to correct past discrimination and inequalities by addressing four of the main pillars of the STI system, viz. changing the national objectives of the system to promote the interests of the previously excluded black section of society, providing sufficient funding to give effect to its objectives, actively advancing previously excluded black scientists and managers, and steer the system in that direction by control mechanisms.

V. Research Approach

The research approach consisted of analyses of published information, mostly government reports and public statements by key role players, available in the public domain, supported by reports on the proceedings of parliamentary committees. Data were considered at several points in time where possible to determine any trends. (Unfortunately, this could not be done in a systematic way, since it sometimes proved difficult to access public documents, while most of them were technically undated.)

The level of analysis, respectively perspective, used in the study was the policy layer, while the execution of policies was located at the intermediary (e.g. funding agencies) and/or performer (research councils) layer [cf. 2; 15].

The study was conceived as an exploratory descriptive study to identify trends and associations, if any, at a relatively high level of analysis upon which further probing could be done at a later stage.

Implicitly, the pre-1994 STI system was used as baseline of the study, but space limitations did not allow such data to be included in this paper. The following notes are offered as a general orientation, however.

The South African STI system up to 1994 was acknowledged [cf. 2] to have been

- Reasonably strong for a middle income country (explicitly acknowledged by at least two post-1994 ministers)
- Set upon minimising the effects of the country's growing international isolation (incl. academic, science, technology and innovation, energy, food, economic and financial, military and political sectors)
- The common mission was self-sufficiency
- The human resource component of the public STI system consisted nearly exclusively of pro-establishment white South Africans. It should be noted though that at the level of R&D performers, a significant part of the historically white English universities (research intensive) and black universities (predominantly teaching institutions), and a relatively small part of the historically white Afrikaans universities (research and teaching) did not associate themselves with the STI mission of the government of the day.

VI. Policy Objectives

A. Dawn of a New Dispensation

The sunset of the apartheid dispensation saw an ambivalent STI period. It could be described as an interregnum [2] characterised by dynamics typical of such periods in the history of a country. On the one hand, the government of the day was maintaining a marking-the-pace as it were, not keen to attend to any queries by the public STI system (e.g. on the dysfunctions of the funding system, known as *framework autonomy*), nor committed to institute new and inevitable changes to the system (e.g. implementing a draft innovation policy). This led to considerable frustration amongst the role players.

The government in waiting, consisting primarily of the ANC and its main partners at that stage, namely the labour movement (COSATU) and the national organisation of NGOs (SANCO), filled that space quite dynamically by, among other things, commissioning "a review of existing S&T policy (...) and of the institutions involved" [16: 22-24] with the financial and professional support of the Canadian IDRC, and in the wake of its report [16] to establish a science and technology forum, *S&T Initiative*, that brought together all the role players to reflect on the nature of an imminent new system [2]. Among the many effects of these initiatives were the following: Firstly, these and related initiatives provided the government in waiting - until then largely alienated from the system – a representative overview of the nature and functioning of the system. Secondly, these initiatives established the new role players' legitimacy, symbolic, if not yet real, power and provisional parameters for planning.

B. Taking Office

The new government took office in April 1994 and the new Department of Arts, Culture, Science and Technology was established with Dr Ben Ngubane and Ms Winnie Mandela as the first minister and deputy minister respectively; Mr Roger Jardine was appointed as first director-general of the new department.

The *White paper on science and technology: Preparing for the 21st century* [17], was the first comprehensive policy produced by that department. It represented a significant rotation of the STI axes yielding the following 'new' dimensions:

- Innovation, i.e. the utilisation and implementation of the results of science, became the *leit motif* of the policy; the system – apparently the first time by a government - being described as a national system of innovation
- Key central functions: policy formulation and control, public resource allocation, initiation of new programmes
- Changing the funding system from formula-based to multi-year zero-budgeting, accompanied by performance criteria and avoidance of micro-management of public research institutions
- Performance measurement by means of peer evaluation and efficiency auditing
- Promotion of human resource development, including mechanisms of redress
- Levelling of regional inequalities

The new dimensions deviated significantly from the apartheid government's whose last significant policy documents dated back to 1988. In the space of two years the publication of the 1996 *White paper on S&T* was followed by a series of other setting-the-baseline reports, including ones on financing and reporting systems, a system-wide review of public sector STI institutions, a national R&D survey, a national research and technology audit, and establishment of an innovation fund.

Policy commitments made during the first four years of the new democratic government can be summarised as follows:

- Focussing on innovation without neglect of basic research
- Priority driven resourcing
- Redressing human resource inequities
- Performance monitoring and evaluation of public research institutions

To a large extent the publication of the *White paper on S&T* set policy parameters for the next 13 or so years in the evolution of STI policy and system in the country. The following paragraphs offer, firstly, an abridged overview on main events that directly or indirectly may have impacted on the policy and its deployment and, secondly, a selected listing of the main developments.

C. Important Events 1998 to 2009

Establishment of the National Advisory Council on Innovation (NACI; 2000)

This council was appointed to advise the Minister and government on a wide range of matters pertaining to innovation policy and systems in the country. The NACI Act specified that the director-general of DST would also serve as CEO of the Council thereby at least significantly limiting, if not diluting, the organisational and critical function of the Council [cf. 2; 10; 18]. In this respect, the NACI Act contrasts rather sharply with the act of the Council of Higher Education which affords that advisory body considerable independence of advice vis-a-vis the Minister of Higher Education and the relevant department [2; 19].

NACI review of the implementation of the White paper on S&T (2002)

In 2002 NACI initiated a review by an international panel to assess the success or otherwise of the implementation of the *White paper on S&T* [19]. In general, the review report was positive about the range and nature of policies, strategies and programmes initiated by the department up to that time. However, one of its main reservations concerned the lag in implementation of policies, which was attributed to a lack of human resources (meaning that the professional staff was too small) for proper implementation.

Science and Technology becoming separate ministry and department (2004)

The third ANC government took office in 1994 and split the ministry of science and technology from that of arts and culture and in doing so created the first separate ministry of S&T in the country's history. This move, on the one hand, raised the political status of science and technology considerably and allowed the ministry to focus exclusively on promoting STI and increase its human resource capacity, on the other. The new department soon afterwards was allocated the oversight function of science and technology across government departments.

OECD review of the South African National System of Innovation (NSI)

In 2007 the OECD published its country report on the South African national system of innovation [10]. This was to a large extent a review of the policy, strategy and institutional landscape and was based on an extensive and comparative analysis and evaluation of the STI system. One of the conclusions read: "The key story has been about reshaping a relatively strong innovation system serving one set of social, economic and political goals towards another strong system serving a very different set of goals" [10: 4]. The report identified the following 'shortcomings' of policy responses to the situation South Africa was facing at that stage:

- Over-emphasis on the role of public R&D institutions in the NSI
- Stretching resources too thinly over too many priorities often preventing a critical mass being reached
- "Too little connection between strategies and their implementation"
- Limited vertical specialisation and differentiation between organisations responsible for governance of the system
- Limited horizontal interaction and coordination between organisations involved in the governance of the system
- Very limited integration between national level policy on the one hand and provincial and local innovation policy and organisations on the other.

Appointment of Minister Pandor in 2009

The inauguration of the fourth ANC government in 2009 saw for the first time an ANC member, Ms Pandor, filling the portfolio of S&T. The previous ministers responsible for this portfolio were from small minority parties. It is generally anticipated in the NSI and the media that this fact would increase the potential impact of the ministry. Another advantage the minister is bringing to her new portfolio, is the fact that she served as Minister of Education in the previous government and in that capacity had gained a great deal of insight into the role of the higher education system in the NSI. The possible effects of her appointment are further explored in a later section of this paper under the heading, *Future perspectives*.

D. Main Policy Developments

The *White paper on S&T* [17], moderated by various events, led to a wide range of strategies, programmes and policy related developments. Some of the more important ones are reflected in the following table.

TABLE 1
OVERVIEW OF SELECTED MAJOR POLICY INITIATIVES

Initiative	Nature	Year
International bilateral agreements	With S&T content: 47; S&T agreements with African countries: 16	1994+
Foresight study	12 relevant sectors, producing 10 thrusts; concluding with medium to long term opportunities	2000
National biotechnology strategy for the RSA	Aimed at gaining lost ground with regard to 3rd generation biotech; introduce new institutional arrangements and specific actions	2001
Review of the 2001/02 KPI reports and annual reports	Reviews balanced scorecard reporting as framework for managing and monitoring performance	2001
National R&D strategy [20]	Replace pre-1994 R&D missions with new set for public funding; based on innovation, HR development and transformation, and effective public S&T system	2002
Advanced manufacturing technology strategy	To improve competitiveness and technological advancement in manufacturing; identified structures, functions, funding and impact criteria.	2002
National R&D survey	First of a new series; Frascati manual	2002
Indigenous knowledge systems policy	Purpose " to recognize, affirm, develop, promote and protect indigenous knowledge systems in South Africa"	2004
SA Large Telescope	Largest single optical telescope in the southern hemisphere	2005
National innovation survey	First one commissioned by government; second one 2008	2005
Square Kilometre Array	South Africa allocated US$ 50 million towards the design, testing and construction of the Karoo Array Telescope (KAT) known as MeerKAT as part of the international submission for hosting the most powerful radio telescope ever	2006

Initiative	Nature	Year
Ten-year innovation plan for South Africa [29]	The objectives of the Plan are to "ensure that public investment in scientific research not only strengthens the effectiveness of South Africa's NSI, but also yields tangible socio-economic benefits for the country" Progress towards knowledge based economy driven by human capital development; knowledge generation and exploitation; knowledge infrastructure; enablers to address innovation chasm. Five grand challenges at centre of focus: Strengthening bio-economy; Space S&T; Energy security; Global change esp. climate change; Human and social dynamics	2007
South African research chairs programme	To stimulate sustained distinction in research while simultaneously generating highly qualified HR capacity to impact on key national and global areas of knowledge - 210 by 2010	2007
Astronomy Geographic Advantage Areas	Declaration of areas for optical astronomy and radio astronomy	2007
South African National Space Agency	To foster research and technological competencies in space science, communications, navigation and space physics	2008
IPR from publicly funded research	Statutory arrangement of relationships between government, institutions and researchers on IP resulting from publicly funded research	2008
Technology Innovation Agency	Statutory funding agency to promote the development of technology-based products, services and enterprises; manages a range of funding and support instruments	2008
Centres of competence	To improve the South African manufacturing industry through R&D	2010?
Regional innovation strategy	Specifying parameters for the establishment of regional innovation systems	2010?

Sources: Various official publications and announcements

E. Conclusions

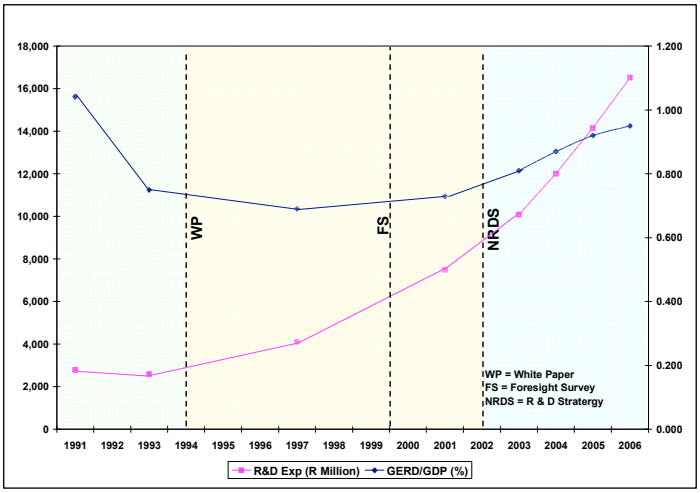
Several conclusions can be drawn from the preceding overview of policy developments since 1994. The following are thought to be relevant within the context of the present paper:

- The liberation struggle brought a wide range of commitments and expectations, also about the role of STI
- The new role players in the democratic government were reasonably well prepared to take over the government STI functions.
- The period up to approximately 2000 produced essential policy initiatives, but the implementation of them lagged behind.
- The policy initiatives were predominantly focussed on the upper end of the innovation value chain – i.e. knowledge production – notwithstanding the original commitment to innovation.
- The primary focus within the innovation context was more on competitiveness than on development of the disadvantaged component of the population.

VII. Enablement of the STI System – Funding as Steering Mechanism

The *White paper on S&T* [17] committed the democratic government to funding the public component of the NSI on a competitive basis. This section offers a brief overview of developments with regard to financial aspects at both departmental level and national levels.

Expenditure on R&D from before the 1994 change of government (i.e.1991/92 to 2006/07) is summarised in Figure 1.



Sources [12; 23].

Fig 1. R&D Expenditure and Intensity – 1991/92 – 2006/07

The following comments are relevant in interpreting the GERD/GDP ratios in the figure:

- The significant decline between 1991 and 1994 could be ascribed to the sharp decline in defence related R&D on the one hand and methodological differences between those two surveys.
- The stabilisation between 1994 to 2002 might be interpreted as a period during which the pre-1994 'business' was continued, since there were not yet new missions for the different sectors; new initiatives were mostly funded by top-slicing existing budgets [2]. It might also imply that the STI system did not share fully in the growth of the economy that followed the democratisation of the country in 1994.
- The steady rise since 2002 is probably a function of economic growth and general and the implementation of new strategic initiatives that followed in the wake of the *White paper on S&T* and the *National R&D Strategy* [20], these included the government's commitment to attain the magic 1% by 2010. (Expressed in constant 2000 values, however, the growth has been much slower since 2000; [21]).

Interestingly enough, the budget of DST, the government department primarily responsible for funding STI, shows a relatively sharp rise since 2000/01, namely from just under R1 billion to R3.1 billion in 2007/08.

The above analyses show that relative investment in the STI system for all intents and purposes stagnated for a decade between 1993 and 2003, although the absolute amount of money increased more than eight-fold.

VIII. Enablement of the STI System – Human Resource Equity

The *White paper on S&T* [17] undertook to correct race imbalances in the provision of human capital. This section offers a provisional assessment of the progress or otherwise the

government has made with regard to its target of correcting the racial balance of the human resource base in the STI system. The following sets of information are offered, viz. the staff composition of the key department DST (Table 3), the management cadre of universities and PRIs, the racial composition of the research force in government and PRIs (Figures 2a and b), the national work force in STI (Figure 3), and NRF student bursaries and scholarships (Figure 4).

TABLE 3
RACIAL CATEGORIES OF DST STAFF

Category	2000/1*	2002/3	2003/4	2004/5	2005/6	2006/7	2007/8
African	221	91	140	147	173	221	255
Coloured	42	10	12	16	13	19	20
Indian	11	7	12	14	16	17	18
White	182	23	26	32	30	34	31
Total	**456**	**131**	**190**	**209**	**232**	**291**	**324**

Source [25].

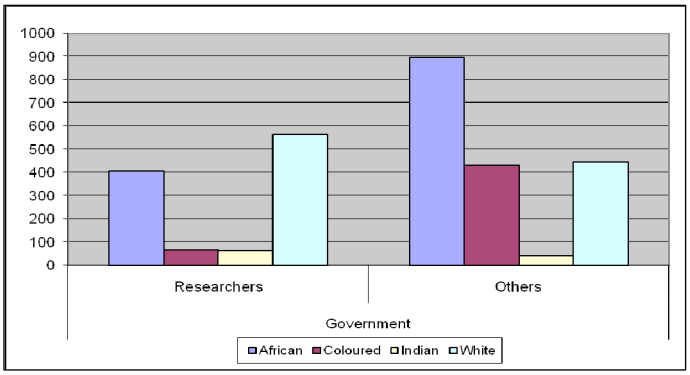
Note: *Including Arts and Culture branch of Dept. of Arts, Culture, Science & Technology

The data reflected in Table 3 [cf. 24 and 25] cover the period before and since the DST was separated from Arts and Culture. It is clear that newly appointed African staff accounted for most of the approximately 30% growth in personnel. To gain a fuller perspective on this finding reference should be made to an earlier study covering the period up to 2001 [26] and showed a black: white ratio of 11:8 in the management cadre. In 2009 this has changed to all almost 7:1.

Ministries, with support of their government departments, are directly responsible for the appointment of the CEO of PRIs and one might expect that the trend seen in DST also reflected in the composition of the top cadre of the PRIs. Seven of the eight CEOs are black and one white. The ratio for the management cadres in 1994 and 1999/2000 of a sample of PRIs reported by [26] was no black senior managers in 1994 and 63% in 2000. The transformation has indeed been comprehensive. The councils of universities are responsible for the appointment of vice-chancellors. By the end of 2009 21 of the 23 vice-chancellors were black and two white.

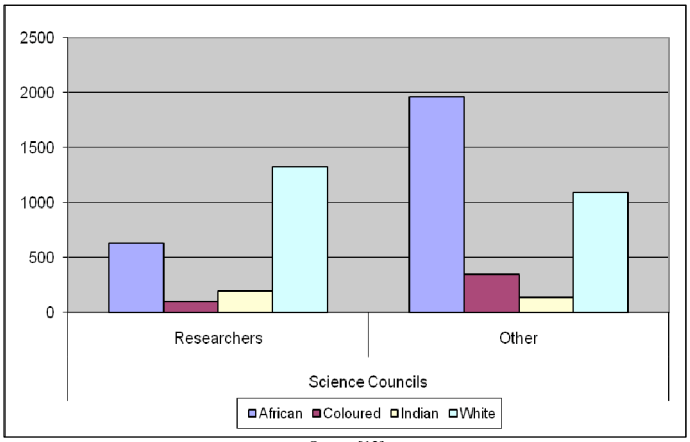
The staff composition of government research entities and science councils are separately shown in Figures 2 and 3. Inspection of these figures clearly shows that white researchers are in the majority in both sectors, while Africans represent the majority in the non-research component of staff.

The next question is what the profile of the total R&D looks like? Data for 2004 and 2006 [12; 25] show that there were nearly four times as many white than black researchers in the system in each of those two years (Figure 3). This pattern is reinforced by Figure 4b which shows that significantly more white than black researchers were NRF grant holders between 2001 and 2008. Although the absolute number of black researchers has increased since 1994, it would seem clear that it would still take a considerable period of time before the ratio would change significantly.



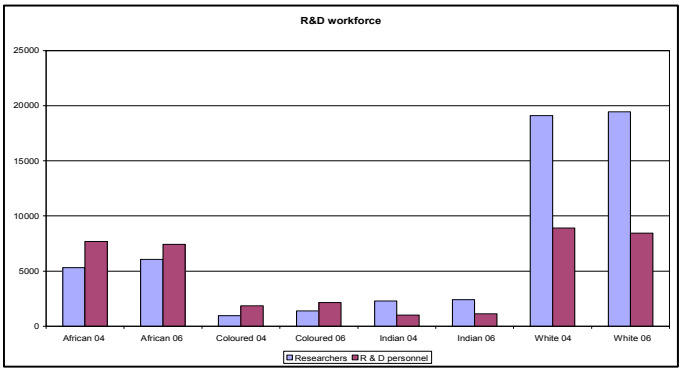
Source [12]

Fig 2a. Racial composition: Government



Source [12]

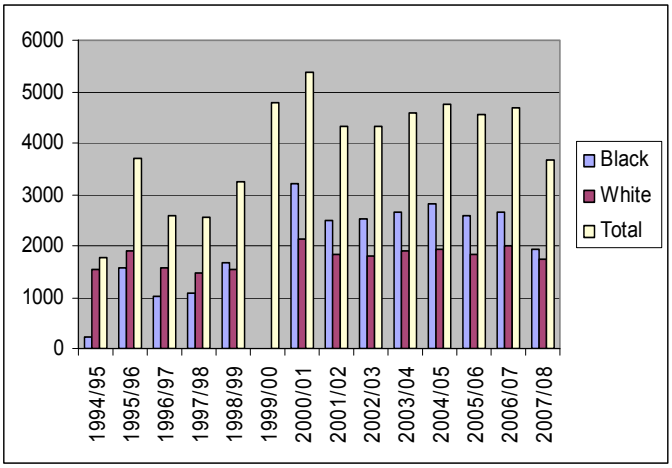
Fig 2b. Racial composition: Science councils



Source [23]

Fig 3. R&D Workforce – 2004 – 2006

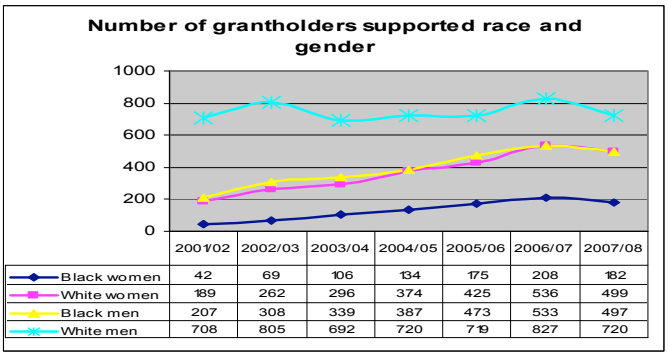
Finally, one indicator of the human capital pipeline for the period 1994-2007, viz. research and student support by the NRF, was inspected to ascertain what the future supply of postgraduate human resources might look like (NRF, 1995-2008). Inspection of Figure 4a shows a consistent increase in the number and proportion of black relative to white students over time and this trend could eventually impact on the number of black researchers entering the STI workforce. However, in terms of support to researchers, it is clear from Figure 4b that black men and white women are supported more or less at the



Source [39].

Notes: 1994-1999: Reflects the support for Natural Sciences and Engineering from the former Foundation for Research Development. 1999/2000-01 includes the Social Sciences and Humanities; 2001+ all science domains, excl. Medical sciences.

Fig 4a. NRF bursaries and scholarships 1994-2008



	2001/02	2002/03	2003/04	2004/05	2005/06	2006/07	2007/08
Black women	42	69	106	134	175	208	182
White women	189	262	296	374	425	536	499
Black men	207	308	339	387	473	533	497
White men	708	805	692	720	719	827	720

Source [39].

Fig 4b. NRF support for researchers 2001-2008

same level, while white men still attract most support and black women the least.

IX. Steering Through Monitoring

The previous sections on policy and steering through resourcing showed that the extent and success with which the South African government has given effect to its undertakings of the early 1990s has been variable. This section surveys the mechanisms of control the government Department of S&T uses in steering the public research institutions, i.e. science councils, including specific mandates, governance structures, governance guidelines and planning, budgeting and reporting mechanisms and cycles.

A. Statutory mandate and governance

PRIs are established, mandated and governed through acts of the South African parliament. They are governed by boards, nominations of which are considered by a parliamentary committee, eventually appointed (including the chair) by the relevant minister and ratified by the cabinet. The CEO of a PRI is also appointed by the relevant minister after recommendation by the board and ratified by the cabinet. The respective functions and roles of boards and executive management are outlined in broad terms in the respective acts and the responsibilities of the board are usually formalised in Board Charters. The regulatory framework consists of several policies, covering corporate governance [30, 38], public finance [31, 32] and general civil service prescripts..

B. Planning, Budgeting and Reporting

The main mechanisms used for steering and controlling PRIs immediately before 1994 were formula-based budgeting, annual financial auditing and annual reports submitted to parliament. The first steps towards performance auditing were taken immediately before 1994. The post-1994 government has over the past 15 years in many respects followed international practice for accountability by applying a management model not unlike the *Government Performance and Results Act of 1993* in the US. [cf. e.g. 27, 35, 36: 191] and evolved a series of steering mechanisms that guide the programmes of the PRIs rather directly. These mechanisms cover the PRI's strategic planning, operational plans and budgets, as well as monitoring and reporting on such activities. The following paragraphs offer selected analyses of the main trends in this regard.

Strategic Planning

By definition PRIs are mandated to allocate a substantial part of strategic plans to addressing the priorities of government as reflected in a range of documents like the Medium Term Strategic Framework [37] (MTSF, sets the priorities for investment) and informs the Medium Term Expenditure Framework (MTEF). Other key government references accounted for by PRIs are the *National R&D Strategy* [20] and the DST *Ten-year plan* [29].

Operational plans and budgets

Two planning documents have to be submitted each year by a PRI, viz. shareholder's compact, and the corporate plan. Each of these is briefly described in the next paragraphs.

The National Treasury provides a set of guidelines [31] applicable to most Major Public Entities. The guideline set out the requirements and format for the Corporate Plan. It also provides a framework for the Shareholder's compact that represents an agreement between government as the majority shareholder of the public entity and the Board of Directors of the public entity.

The annual financial year stretches from 1 April to 31 March. Planning commences when the Department of Science and Technology submits expected revenue and expenses into the national budgeting process that find expression in the Expected National Expenditure (ENE). Corporate plans specify the outputs that are to be produced, performance indicators, performance targets and available resources. The Corporate Plan has to be approved by the Minister, and is then presented to the Parliamentary Portfolio Committee for Science and Technology. In addition to the Corporate Plan, the

Shareholder's Compact formalizes the relationship between the signatories and focuses on the performance targets.

Monitoring and reporting

Until 1994 the main reporting document was the annual report. However, it became necessary, in terms of the intention of the *White paper* [17] that entities should be required to submit to DST not only financial information but also on non-financial information referred to as 'performance information', in the form of Key Performance Reports, quarterly progress reports and an annual report. In addition to the Annual Report that is audited by the office of the government's auditor general, annual performance information are required in the form of Key Performance Reports (since 2001), and quarterly progress reports (since 2007). Table 4 offers an overview of the planning and reporting cycle.

TABLE 4
PERFORMANCE REPORTS TO BE SUBMITTED BY PRI;S

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Planning cycle for coming year												
Budget submission												
Business Plan												
Shareholder Compact												
Prior year Performance Reporting												
KPI Report												
Annual Report												
In-year Performance Reporting												
Quarterly Report												
Contract Reporting												

Quarterly Report Contract Reporting

All performance reports have to be signed off by the Chairman of the Board. Official responses by DST normally follow submission of these reports (these were not accessible to analysis in this study):

- Quarterly report: Feedback to the Board on areas where (incl. specific line items) improvement is required.
- KPI reports: Infrequently, DST would provide detailed feedback to the top management of the PRI.
- Annual Report: It has to be approved by officials of DST prior to printing. Once printed is analysed by DST, submitted and presented by the PRI to the Minister and eventually to the Parliamentary Portfolio Committee.

C. *Provisional Conclusions*

- The number of governance and control measures has increased and become increasingly formalised, while there are signs that they are 'audited' to in an increasingly detailed way
- The above must of necessity require competent human resources with relevant experience and skills at departmental level to monitor performance and exercise control (without access to the detailed feedback by government to PRIs one could only conclude that a significant responsibility would be expected of the officials involved in this function); the danger of micro-management lurks around the corner
- Fiscal and performance controls are being aligned and performance reporting has increased in importance;
- The size of the budget may not justify the level of control i.e. the economy and efficiency of exercising control have to be established.
- The advantage of the current approach is that it promotes good governance and transparency. The disadvantage is that it may result in micro-management especially because the bulk of the budget is ring-fenced.

X. CONCLUSIONS

This study explored whether and to what extent the South African government, through its department of S&T (DST), has impacted on some of the main pillars of the STI system. Information used to assess developments over the past 15 years included new policy initiatives, funding allocations, human resources profile and control mechanisms applicable to science councils. The study was projected against the backdrop of a middle income/developing country with a rather complex socio-economic make-up but a reasonable well developed STI system when the first democratic government came to power in 1994. The analyses showed

- Firstly, that the core STI missions were changed substantially over time. However, the implementation of such policy changes was uneven and tended to concentrate on the upstream part of the innovation value change, namely R&D and in areas such as space science. Furthermore, a key commitment to utilise STI for the benefit of the disadvantaged sections of the population as contained in the first policy document, namely the White paper on S&T, seems to have been neglected.
- Secondly, the funding of the STI system has grown strongly in absolute terms, but the system does not seem to have really shared in the relatively strong economic growth between 1994 and 2002. To some extent the stagnation of the GERD/GDP ratio may reflect the involvement in policy development not having been accompanied by equally rigorous implementation.
- Thirdly, extensive transformation has been brought about on the human resource dimension in terms of race equity. This conclusion applies especially to the top structures of government itself and those institutions over which they exerted direct control. However, at the levels of professional staff, whites in that sector still represent a relatively large majority. This also applies to the total R&D workforce where African scientists and researchers represent approximately a third of the white component. Information on the input side, as measured by public funds for postgraduate studies and research, suggests that the picture would probably not change significantly over the next decade.
- Fourthly the DST has introduced a range of new steering mechanisms and significantly tightened its control on

public research institutions. This is in line with intensified government controls in general, that are probably not unique to this country. However, using these monitoring and control mechanisms will eventually put a significant stress on the bureaucracy and the relationship between the elements of the multi-layered system. One can pose the question whether the *White paper*'s [17] commitment to control without detail management will be upheld.

XI. FUTURE PERSPECTIVES

The exploratory analyses reported above offer a basis for reflecting on the further evolution of the South African STI system. Three additional sets of information can be added to the qualitative equation which would allow a limited set of cautious perspectives on the future. The additional information included in the following future perspectives are, firstly, the general policy of the new ANC government as reflected in, among others, public statements by the current Minister of S&T, secondly the corporate strategy of the Department of S&T [21] and, thirdly, the current economic crisis. These perspectives are offered without additional discussion.

A. Development Imperative

The South African government's commitment to service the needs of the disadvantaged part of the population can be expected also to effect STI priorities, especially since the STI system appears so far to have focussed on high tech and not so much on development needs as prime target. This focus can best be summarised under the title of innovation for development. It would cover broad-based innovation, IKS, public understanding of STI in deep rural areas, etc.

B. The implementation Challenge

At least three reputable assessments over the past decade have noted that government was very productive with regard to policy development, but that implementation of those policies seemed to lag further behind than what would have been expected. The analyses in this paper did show, though, that progress has been made over the past approximately five years. Future governance of the STI system could be expected to insist on explicit time frames for implementation and monitoring and evaluation schedules.

C. Financing of the STI System

Political commitment to increase GERD to reach 1% of GDP over the short term seems to be very serious. What is not clear at this stage is how deep the impact of the current economic crisis will be. Over the short, it would seem that the best way for the STI community not to slip back, would be to become more effective and efficient. This would require taking monitoring and evaluation seriously, to consider seriously how research findings can be utilised better – even in the case of Mode 1 - , and to foster collaboration with other professionals, institutions and countries more purposefully, to name but three mechanisms of raising STI impact under conditions of economic uncertainty.

D. Increasing Control

It can be expected that control will be tightened further in the near future. Intensified control can be expected due to the government commitment "to achieve visible and tangible socio-economic development within the next five years" [33]; the creation in the Presidency of a monitoring and evaluation competency to evaluate performance of government [33]; and the expectation to be efficient within the budgetary constraints of the current economic climate. However, the danger of micro-management and the demands this would put on the professionalism of the bureaucracy may become mitigating factors.

E. National dynamics

The above - and other perspectives – would eventually be influenced by the unfolding of the country's future. In this regard, it may be useful to refer to the so-called 2020 *Dinokeng* scenarios [34] that describe three possible futures for South Africa in terms of the relationship between the state and civil society, viz. *Collaborative and enabling state*, *Interventionist and directive state*, and the *Corrupt and ineffective state*. The first scenario would provide an enabling context for STI in future to impact on economic growth and the improvement of the quality of life of all the country's people. The second scenario would require a much stronger human capital base than what is available at present and the end result would probably be increased steering and a narrower definition of the STI mission. The third scenario would probably lead to the collapse of the STI system as described in this paper.

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REFERENCES

[1] Mandela, N.R. 1994. *Inaugural Statement, 10 May 1994.* Pretoria: Government Printer.
[2] Marais, H.C. 2000. *Perspectives on Science Policy in South Africa*. Menlo Park: Network Publishers.
[3] Presidency (RSA) 2008. *Development Indicators – 2008*. Pretoria: Government Printer
[4] Statistics South Africa (2008). *Mid-year Population Estimates – July 2008.* Pretoria: Government Printer.
[5] UNICEF (2007). www.unicef.org/infobycountry/southafrica_statistics.html
[6] CIA 2009. *The World Fact Book*. http://www.cia.gov/library/publications/the-world-fact-book/
[7] Statistics South Africa 2009. *Consumer Price Index – May 2009.* Pretoria: Government Printer.
[8] Statistics South Africa 2008. *Quarterly Labour Force Survey – 2008.* Pretoria: Government Printer.
[9] National Advisory Council on Innovation 2008. *South African Science and Technology Indicators - 2008*. Pretoria: NACI.
[10] OECD 2007. *Review of the South African Innovation Policy*. Paris: OECD.
[11] Department of Education 2009. *Education Statistics – 2007*. Pretoria: Government Printer.
[12] Department of S&T 2009. *National Survey on Research and Experimental Development – 2006/07.* Pretoria: Government Printer.
[13] Academy of Science of South Africa 2006. *Report on a Strategic Approach to Research Publishing in South Africa – 2006.* Pretoria: ASSAf.

[14] Shils, E. (Ed) 1968. *Criteria for Scientific Development: Public Policy and Political Authority*. Cambridge, Mass.: MIT.
[15] Rip, A. 1998. The dancer and the dance: Steering in/of science and technology. *Management and Policy in Higher Education.*
[16] IDRC. 1993. *Towards a Science and Technology Policy for a Democratic South Africa.* Johannesburg: IDRC.
[17] Department of Arts, Culture, Science and Technology 2001. *South Africa's White Paper on Science and Technology: Preparing for the 21st Century*. Pretoria: Government Printer.
[18] NACI Review Panel 2002. *Audit of the Performance of South Africa's National Advisory Council on Innovation*. Pretoria: NACI.
NACI Review Panel 2008. *A Review of the National Advisory Council on Innovation*. Pretoria: NACI.
[19] Pistorius, C. 2008. *Providing Science Advice to Government in South Africa: Review and proposals.* Pretoria: University of Pretoria.
[20] Department of Science and Technology 2002. *South Africa's Research and Development Strategy.* Pretoria: Government Printer.
[21] Department of Science and Technology 2009. *2009/10 Corporate Strategy*. Pretoria: DST.
[22] Foundation for Research Development. 1995. *Annual Report 1994-1995*. Pretoria: FRD.
Foundation for Research Development, 1996. *Annual Report 95/96.* Pretoria: FRD.
FRD 1997. *Annual Report Foundation for Research Development 1996-1997*. Pretoria: FRD.
FRD 1998. *97/98 Annual Report FRD.* 1998. Pretoria: FRD.
FRD 1999. *Annual Report 98 99.* Pretoria: FRD.
[23] Department of National Education 1993. *Resources for R&D: Results of survey, 1991/92*. Pretoria: Government Printer.
Foundation for Research Development 1995. *Resources for R&D: 1993/94.* Pretoria: FRD.
Department of Arts, Culture, Science and Technology 2000 (also 2003; 2005). *Survey of Resources Allocated to Research and Development 1997/98* (also *2001/02; 2003/04*). Pretoria: Government Printer.
Department of Science and Technology 2008. *National Survey on Research and Experimental Development – 2005/06*. Pretoria: Government Printer.
Foundation for Research Development 1996. *South African Science and Technology Indicators.* Pretoria: FRD.
[24] Department of Arts, Culture, Science and Technology 2001. *Annual Report 2000/2001*. Pretoria: Government Printer.
[25] Department of Science and Technology 2003. *Annual Report 2002/2003*. Pretoria: Government Printer.
DST 2004. *Annual Report 2003/2004.* Pretoria: Government Printer.
DST 2005. *Annual Report 2004/05*. Pretoria: Government Printer.
DST 2006. *Annual Report 2005/06.* Pretoria: Government Printer.
DST 2007. *Annual Report 2006/07*. Pretoria: Government Printer.
DST 2008. *Annual Report 2007/08*. Pretoria: Government Printer.
[26] Marais, H.C. & Pienaar, M. 2001. *Empowerment in Higher Education and Research since 1994*. Paper read at annual conference of the South African Academy for Science and Arts, Pretoria. (Unpublished)
[27] Cozzens, S.E. 1999. Are New Accountability Rules Bad for Science? *Issues in Science and Technology Online*. Summer 1999. http://www.nap.edu/issues/15.4/cozzens.htm
[28] NACI Review Panel 2002. *Evaluation of the Implementation of the South African Innovation Policy.* Pretoria: NACI.
[29] Department of Science and Technology. *10-Year Innovation Plan.* Pretoria: Government Printer.
[30] Institute of Directors of Southern Africa 2009. *Draft code of Governance Principles for South Africa 2009.* King Committee on Governance. http://www.Iodsa.co.za
[31] National Treasury 2002. *Guideline Framework for Corporate Planning and Shareholder's Compact applicable to Schedule2, 3B & 3D Major Public Entities*. Pretoria: National Treasury.
[32] National Treasury 2007. *Framework for Managing Programme Performance Information.* Pretoria: National Treasury.
[33] Government Communication and Information System 2009. *Statement by President Jacob Zuma on the Appointment of the New Cabinet, 10 May 2009*. Pretoria: GCIS
[34] The Dinokeng Scenarios 2009. *Three Futures for South Africa*. www.diknokengscenarios.co.za.
[35] The Presidency. 2007. *Policy Framework for the Government-wide Monitoring and Evaluation System*. http://www.thepresidency.gov.za
[36] Organisation for Economic Cooperation and Development 2006. *OECD Science, Technology and Industry Outlook*. Paris: OECD.
[37] The Presidency 2009. *Together Doing More and Better. Medium Term Strategic Framework to guide Government's programme in the electoral mandate period (2009-2014).* Pretoria: Government printer.
[38] Department of Public Enterprises 2002. *Protocol on Corporate Governance in the Public Sector*. http://www.dpe.gov.za.
[39] National Research Foundation 2008. *Annual Report – 2007/08*. Pretoria: NRF.
NRF 2002 (also 2003-2007). *Annual Report – 2001/02* (also *2002/03-2006/07*). Pretoria: NRF.